



Scale Effect Aspects for Correlation of CPT Data in Foundation Analysis and Design

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ABSTRACT

The cone penetration test (CPT) is the most applicable in-situ tests in geotechnical practice, due to its simple, fast, reliable, and economical nature. The scale effects between the pile to resistance and CPT cone is studied by different researchers, so the effects of these factors are not taken in creating a relation between CPT sleeve friction and pile shaft resistance. The main purpose of this research is studying these effects on shaft resistance. The shear strain due to CPT sounding and pile load tests and the scale effect aspects between CPT and pile related to the shear strain levels were studied. Excess pore pressure effects in fine grained soils generated due to the rate of penetration was individually considered.

This database consists of 42 case histories of pile load tests including the CPT profile, derived from different sites that have been used for evaluation of the current approaches. In this paper, the proposed method for determining the shaft bearing capacity, with considering scale effects was evaluated and compared with four methods including: Clisby et al. (1978), Tumay and Fakhroo (1981), Price and Wardle (1982), and Takesue et al. (1998). The results of analysis by the proposed method demonstrate good accuracy in comparison with the other methods for estimating the shaft capacity.

KEYWORDS

Scale Effect, Cone Penetration Test, Pile, Static load Test, Friction Resistance (fs).

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1- BRIEF INTRODUCTION

The cone penetration test (CPT) is the most applicable in-situ test in geotechnical practice. In recent decades several different methods have been provided for determination of pile bearing capacity using CPTu data. Some of methods are based on direct relations between pile shaft resistance and CPT sleeve friction (f_s), such as: Clisby et al. (1978), Tumay and Fakhroo (1981), Price and Wardle (1982), and Takesue et al. (1998). In the current approaches, scale effects are not considered between the shaft bearing capacity and CPT sleeve friction. Generally, three effective factors including the diameter, penetration rate, and soil type are regarded as the scale effect aspects.

2- METHODOLOGY

The database included 42 case history records of constructed piles with CPT profile and pile loading test results collected from 24 various sites, have been used to evaluate the proposed method. This approach has been associated to different generated shear strain values in pile and CPT penetration. By increasing pile diameter, penetration rate and soil sensitivity, more generated shear strain values and as a result larger shear stresses would be obtained. Thus, to estimate the relationship between generated shear strain in pile and cone penetration test, the primary following equation has been proposed:

$$\frac{\gamma_{pile}}{\gamma_{CPT}} = \left(\frac{v_{pile}}{v_{CPT}}\right)^a \left(\frac{D_{pile}}{D_{CPT}}\right)^b \left(\frac{1}{R_f}\right)^c \quad (1)$$

Moreover, the following equation similar to the Takesue method has been estimated for considering generated excess pore pressure during cone penetrating:

$$r_s = f_s(1 + \alpha\Delta u) \quad (2)$$

3- MAIN CONTRIBUTIONS

To establish the relationship between shear strain in pile and penetrometer, equation (1) has been calibrated by using the case histories and the iteration method to obtain the best fit in diagram $\tau/\tau_{max} - \gamma$. Therefore, the proper value for a, b and c parameters resulted in 0.6, 0.45 and 0.5, respectively.

$$\frac{\gamma_{pile}}{\gamma_{CPT}} = \left(\frac{v_{pile}}{v_{CPT}}\right)^{0.6} \left(\frac{D_{pile}}{D_{CPT}}\right)^{0.45} \left(\frac{1}{R_f}\right)^{0.5} \quad (3)$$

Moreover, the appropriate value of α equal to 0.002 caused the best result to consider the pore pressure effect in equation (2).

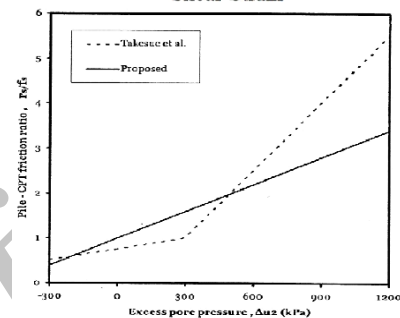
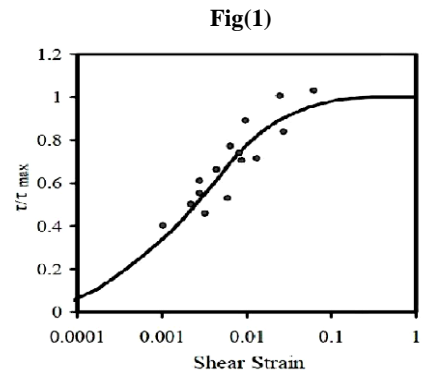
$$r_s = f_s(1 + 0.002\Delta u) \quad (4)$$

4- SIMULATION RESULTS

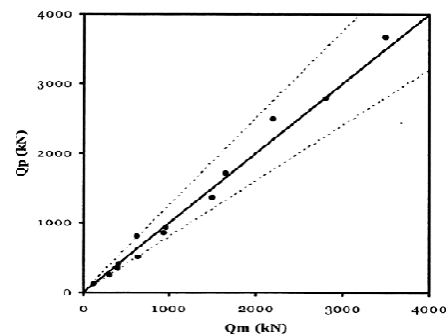
Reduced ratio caused by lower strain levels during the pile

installation compared to CPT penetration is shown by $\tau/\tau_{max} - \gamma$ diagram in Fig 1.

In Fig. 2, the correction of pore pressure effect according to the proposed and Takesue method is illustrated.



The results of statistical evaluation for estimating the ratio of shaft resistance to the measured one, have been illustrated in Fig. (3). The average and standard deviation calculated value are equal to 0.97 and 0.13, respectively. The results indicate the appropriate calibration accuracy.



The results indicate the appropriate calibration accuracy. In this paper the proposed method for estimation shaft bearing capacity, with regards to the scale effects has been evaluated and compared with four methods including: Clisby et al. (1978), Tumay and Fakhroo (1981), Price and Wardle (1982), and Takesue et al. (1998). The results by the proposed method for pile shaft capacity directly from CPT sleeve friction demonstrate good accuracy in comparison to the other methods.

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